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ARS SPECIAL REPORT

Hybrid Lambs

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SUMMARY

Hybrid lambs are the result of the mating of sheep of 2 or more different breeds. A great deal of such crossbreeding has been carried on by sheep raisers, but very few long-time scientific studies have been made to determine the advantages of hybrid lambs over single-breed lambs in the production of meat and wool.

Research has been under way in the U. S. Department of Agriculture since 1947 to determine the advantages of crossbreeding. The entire research program covers a 40-year period. Consideration has been given to lamb mortality, lamb production per ewe, and wool production per ewe, as well as carcass grade and meat quality factors.

The first hybrids produced were two-way crosses, the offspring of various matings of mutton-type Shropshire, Southdown, and Hampshire purebreds. The second group of hybrids produced were three-way crosses, the offspring of two-way cross ewes bred to purebred rams of a third breed, either of mutton or wool types.

In all production comparisons the two-way and three-way crosses outclassed the averages of the purebred parents. The use of a wool-type ram in the three-way crossings increased quality and production of wool significantly and did not materially lower carcass quality.

These results are based on the use of purebred flocks in which inherent ability to produce meat and wool has been highly developed. Scientists emphasize the importance of maintaining purebred flocks of highest quality and efficiency for successful commercial crossbreeding.

Information in this report was furnished by the Animal and Poultry Husbandry Research Branch, Agricultural Research Service

HYBRID LAMBS

Hybrid lambs that outproduce the finest strains of purebreds in flesh and fleece--and at a lower mortality rate--hold promise for the Nation's sheep industry. Developed at the U. S. Department of Agriculture's Research Center, Beltsville, Md., two-way and three-way crosses of purebred Hampshires, Shropshires, Southdowns, and Merinos have consistently outproduced parent stock. Increased wool production of crossbreds is particularly significant in view of efforts being made to increase domestic production of wool.

Development of hybrid lambs does not, however, decrease the importance of purebred sheep in the breeding program. Long-term USDA experiments have demonstrated the success of raising such hybrids from purebred flocks. Further, they have shown the importance of maintaining high-quality purebred flocks as a means of transmitting outstanding meat- and wool-producing characteristics to the progeny.

Sheep raising in the United States, except in the range area, is conducted mostly on a small flock basis. Farm flocks often include fewer than 25 sheep and seldom more than a few hundred. The majority of farm flocks are made up of sheep of the medium-wool, mutton type. The sale of lambs represents 70 to 80 percent of the total flock income, and wool the remaining 20 to 30 percent.

Many sheepmen also produce crossbred lambs. The ewes may be purebreds, high grades, or crossbreds and are mated with a ram of another breed. This practice is usually followed by flock owners who are convinced that crossbreeding produces more vigorous lambs and results in increased lamb production. The wealth of information on purebred and crossbred lambs, obtained in the experiments conducted by the Agricultural Research Service, has established the validity of this conviction.

The ARS breeding work has extended over 40 years. In the first phase high-quality purebred flocks of Hampshires, Shropshires, and Southdowns were developed. In the second phase these three breeds were crossed to produce two-way hybrids. In the third phase, two-way crosses were bred to purebred rams to give three-way crosses. Rams used to produce the three-way crosses were of four breeds: Hampshires, Shropshires, Southdowns, and Merinos. Merino blood was introduced into some of the crosses to determine the effect of fine-wool inheritance on quantity and quality of meat and wool production by the offspring.

THE FIRST PHASE--ESTABLISHING THE FLOCK

The first phase began about 40 years ago with the purchase of purebred, mutton-type Hampshires, Shropshires, and Southdowns from outstanding breeders in the United States, Canada, and Great Britain. The

strains were perpetuated and improved by selective mating and line breeding until they possessed an even higher degree of excellence in type and mutton form. Careful and complete records were kept through the years.

THE SECOND PHASE--TWO-WAY CROSSES

The second phase began in 1947. The objective was to determine the effect of crossbreeding on the vitality of young lambs and on the rates of meat and wool production.

Crossbreeding is the mating of two animals of different breeds. It has been undertaken rather extensively with sheep because it provided a ready means of combining excellence in both meat and wool with maximum efficiency.

Crossbreeding has been used in the foundation of many breeds of sheep. The Columbia and Targhee, for example, were developed following crossbreeding to produce a more productive sheep than the fine-wool types for some Western ranges. Cooperative research between the Department and various State agricultural experiment stations was involved in these developments. Although these breeds are raised in the East, they are not nearly as common as on the Western rangelands.

Crossbreeding has also been undertaken to compare purebreds and crosses on the basis of livability and production. These have generally not included comparisons of crossbreds with both parent breeds kept under the same conditions. For that reason, the USDA began a long-term comparison in 1947.

ARS researchers set out to learn whether factors of economic importance, such as number of lambs saved, amount of wool produced, weight of ewes, and pounds of lamb produced per ewe, were larger among hybrids than among purebreds.

The following production index was worked out to afford a basis for comparison:

1. The annual fleece weight of the mother ewes was multiplied by 2.5.
2. The weight of ewe lambs was multiplied by 1.1.
3. The results obtained in steps 1 and 2 were added to the weight of ram lambs. All lamb weights were taken between 137 and 143 days of age.
4. This total was multiplied by 100.
5. The result was then divided by the weight of the mother ewe on the November first prior to lambing to provide the production index number.

Four two-bred crosses were made among the three mutton-type breeds in the ARS flock. At the same time purebred matings in each breed were continued to maintain these pure lines for seed stock and to provide comparisons between the purebred and crossbred offspring. Both groups were fed and managed in the same way.

The program has been under way for 8 years. In that period hybrid lamb losses by weaning-time were 6.8 percentage points less than purebred lamb losses, and the average production index of the ewes producing hybrids was about 8 index points higher than that of the ewes producing purebred lambs (table 1). These results represent a reduction of about one-fourth in infant mortality for crossbred lambs. In addition, crossbred lambs outweighed purebreds at weaning-time by about 5 pounds.

Table 1.--Comparison of two-way crosses[1] and purebreds, 1948-55 averages

Item	Number of ewes	Lambs lost	Production index
		Percent	
Two-way crosses[2]	518	21.4	67.3
Purebreds[2] [3]	711	28.2	59.2
Differences	.....	6.8	8.1

[1] A two-way crossbred is produced by mating rams and ewes of different breeds.
[2] Mutton-type.
[3] Purebred averages were weighted by the relative contributions of the various breeds in the two-way crosses.

Of the crosses undertaken, the Shropshire ram X Hampshire ewe had the highest production index and the lowest lamb mortality. This is not surprising since the Hampshires had the highest ewe production index and the lowest lamb mortality among the mutton-type purebreds.

THE THIRD PHASE--THREE-WAY CROSSES

Three-way crossing, the third phase, began in 1950. The objective was to determine the effect of a third breed on vitality and on meat and wool production. In each crossing the ram was of a breed not represented in the breeding of the two-way-cross ewe. For example a Shropshire ram was bred to a Southdown-Hampshire ewe, a Southdown ram bred to a Shropshire-Hampshire ewe, and so on. But not all the rams used in producing three-way crosses were of the mutton type. Some crossings were made with fine-wool rams to determine the effect on meat and wool production. Merinos were chosen for this purpose. The three-way crosses, then, can be divided into mutton-type three-way crosses, and Merino three-way crosses.

Mutton-type Three-Way Crosses

Rams of each of three mutton breeds were bred to two-way-cross ewes of the mutton breeds. Each of the lambs resulting from these crosses was of three different breeds. A total of four crosses were undertaken as shown in table 2.

Table 2.--Results of crossing in the production of mutton-type three-way crosses, 1951-55 averages

Three-way crosses	Number of ewes	Lambs lost	Production index
		Percent	
Shropshire X Southdown-Hampshire	106	11.8	78.5
Hampshire X Southdown-Shropshire	94	23.4	76.2
Southdown X Hampshire-Shropshire	45	8.6	72.5
Southdown X Shropshire-Hampshire	43	21.8	65.1
Average	.....	16.4	73.1

The mutton-type three-way crosses had a higher average production index and a lower average lamb mortality than either the two-way crosses or the purebreds (table 3).

Table 3.--Comparison of mutton-type crosses with mutton-type purebreds, 1951-55 averages

Item	Number of ewes	Average lambs lost	Average production index	Average lambs lost	Average production index
		Percent		Percent	
Three-way crosses	288	16.4	73.1	16.4	73.1
Two-way crosses	299	23.6	66.3	.....	.....
Purebreds[1]	440	.....	.....	26.4	59.2
Differences	.....	7.2	6.8	10.0	13.9

[1] The purebred averages were weighted by the relative contribution of the various breeds in the three-way crosses.

Merino Three-Way Crosses

To increase the quantity and quality of wool, Merino rams were used on some of the mutton-type two-way-cross ewes. A flock of top-quality, purebred Delaine Merinos was assembled. Merino ewes were bred to Merino rams to build up the flock. At the same time, Merino rams were bred to two-way-cross ewes of Hampshire and Shropshire breeding to produce three-way-cross lambs.

Lamb mortality and production index figures averaged better than did either the two-way crosses or the purebreds (table 4). Purebred figures, in this case, include those of the purebred Merinos, which had a lower lamb mortality and a higher production index than the mutton-type purebreds.

Table 4.--Comparison of Merino three-way crosses with two-way crosses[1] and purebreds,[2] 1951-55 averages

Item	Number of ewes	Average lambs lost	Average production index	Average lambs lost	Average production index
		Percent		Percent	
Merino three-way crosses.	95	18.4	73.85	18.4	73.85
Two-way crosses.....	299	23.6	66.30	.....	.....
Purebreds[3].....	503	.....	.....	23.6	65.95
Differences.....	.....	5.2	7.55	5.2	7.90

[1] Two-way crosses were all of the mutton-type.
[2] Purebreds included Hampshire, Shropshire, Southdown, and Merino breeds.
[3] Purebred averages were weighted by the relative contributions of the various breeds in the three-way crosses.

Production index figures also averaged better for the Merino three-way crosses than for the mutton-type three-way crosses but a larger percentage of the Merino cross lambs were lost by weaning-time (table 5).

Table 5.--Comparison of Merino three-way crosses with mutton-type three-way crosses, 1951-55 averages

Item	Number of ewes	Average lambs lost	Average production index
		Percent	
Merino three-way crosses.....	95	18.4	73.85
Mutton-type three-way crosses.....	288	16.4	73.10
Differences.....	.....	2.0	0.75

WOOL PRODUCTION

The fleece weights of the lambs resulting from each crossing shows an advantage of the crossbreds, particularly those of the Merino three-way crossing. Fleece weights in each case refer to clean scoured wool on a commercial basis and were taken after 1-year's growth (table 6).

Table 6.--Fleece weights of yearling purebreds and crossbreds used in ARS tests, 1949-55 averages

Item	Number of fleeces	Average weight per fleece of clean scoured wool, commercial basis[1]		
		Pounds	Pounds	Pounds
Merino three-way crosses.....	49	5.45	.....	.....
Two-way crosses[2].....	145	.....	4.39	.....
Mutton-type three-way crosses.....	102	.....	.....	4.30
Purebreds[3].....	324	[4] 4.61	[5] 3.52	[6] 3.35

[1] Included a calculated moisture content of 12 percent, making these weights comparable with all wool market reports.
[2] Mutton-type.
[3] Purebred averages were weighted by the relative contributions of the various breeds in the three-way crosses.
[4] All purebreds, including Merinos, 1952-55.
[5] Hampshire, Shropshire, and Southdown, 1949-55.
[6] Hampshire, Shropshire, and Southdown, 1952-55.

Two-way-cross-yearling fleeces averaged nearly 25 percent more in weight than did the fleeces of the mutton-type purebreds, despite the fact that both parents of the two-way crosses were of the mutton breeds.

Mutton-type three-way-cross-yearling fleeces averaged 28 percent more in weight than did the fleeces of mutton-type purebreds, but slightly less than the weight of two-way-cross fleeces.

Merino three-way-cross-yearling fleeces averaged about 18 percent more in weight than did the fleeces of purebreds and more than 24 percent over the fleeces of mutton-type two-way crosses. In addition, the wool of the Merino three-way crosses classified a grade finer on a quality basis than those of the mutton-type animals, both purebred and crosses. The combination of greater weight and finer grade made the wool return per animal of the Merino three-way crosses $2.73 greater than that of the mutton-type purebred, using 1948-54 average prices for clean, fleece-shorn wool at Boston (table 7). In other words, the wool return of the Merino three-way crosses was one-half more than that of the mutton-type three-way crosses. The two-way and three-way crosses of mutton type yielded the same quality wool as the mutton-type purebreds and enjoyed only a yield advantage.

Table 7.--Comparison of value of average Merino three-way-cross fleece and of mutton-type purebred fleece

Item	Average weight per fleece	Average price per pound[1]	Average value per fleece
	Pounds	Dollars	Dollars
Merino three-way crosses	5.45	[2] 1.60	8.72
Purebred	4.61	[3] 1.30	5.99
Difference	.....	.....	2.73

[1] 1948-54 average prices for graded fleece shorn wool, good French combing and staple, clean basis, Boston. Agricultural Marketing Service, U.S. Department of Agriculture, Supplement for 1955 to Wool Statistics and Related Data (U.S.D.A. Statistical Bulletin No. 142).

[2] Price for one-half blood wool, the market grade for wool of the Merino three-way crosses.

[3] Price for three-eighths blood wool, the market grade for wool of the mutton-type purebreds.

MEAT PRODUCTION

Meat production is more important to the income of the farm flock owner than wool production. A well-finished carcass weighing 35 to 45 pounds is preferred in most markets, but carcass quality is also very important.

The two-way crosses exceeded the mutton-type purebreds in weight at about 140 days of age, and the carcasses of the crossbreds graded one-third of a grade higher than the average of the mutton-type purebred carcasses. The two-way-cross lambs dressed slightly higher than the average for the purebreds and were slightly fatter as shown by the percentage of separable fat in the rib cut.

The mutton-type three-way crosses exceeded the mutton-type purebreds and the two-way crosses in weight at the same age and graded the same as the average of the two-way-cross carcasses. Three-way-cross lambs dressed slightly higher and had a higher yield of the preferred cuts than did the average mutton-type purebred.

The Merino three-way crosses exceeded the other crosses and the purebreds in weight and approached the average of the mutton-type lambs in carcass grade. They might have been expected to fall well below the mutton-type in this respect, since Merino carcasses grade low. A decided lowering of carcass grade or meat quality would partially offset the wool and weight advantages of the Merino three-way crosses, since each carcass grade brings about a dollar more a hundredweight than the grade below it. The Merino three-way-cross lambs were equal to the three-way-mutton-type lambs in dressing yield and separable fat in the rib cut. The maintenance of carcass grade, despite the use of a wool-type ram, is one of the most encouraging aspects of the Merino three-way-crossing work.

All three crossbred groups were compared with mutton-type purebred lambs on a number of meat quality factors. Tenderness was determined by the Warner-Bratzler Tenderness Testing Device, which measures the pressure required to shear a sample of heated meat. Quantity of juice was determined by pressing cooked meat samples, and taste panels were employed to compare the quality of the juice, flavor, and aroma. On all points, all three crossbred groups compared favorably with the average of the purebred mutton types.

SUMMARY

The two-way crosses were superior to the average of the mutton-type purebreds in lamb livability and in production-index measurements. They equalled the mutton-type purebreds in average carcass quality and exceeded them in wool production.

The mutton-type three-way crosses were superior to the average of mutton-type purebreds and the two-way crosses in lamb livability and production index measurements. They equalled them in average carcass-quality and exceeded the mutton-type purebreds in wool production.

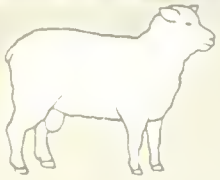
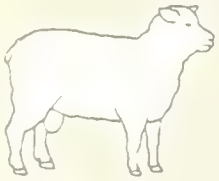
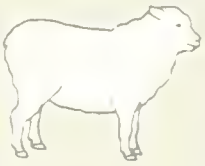
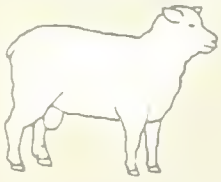
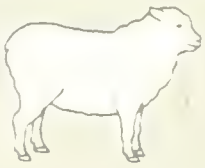
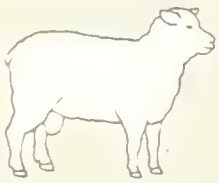
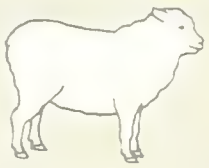
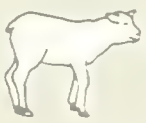
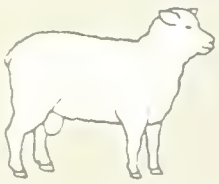
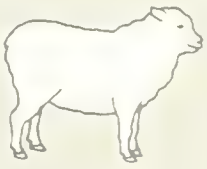
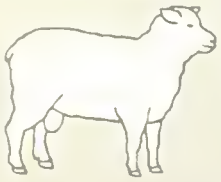
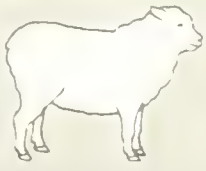
The Merino three-way crosses were superior to the average of all the crosses and purebreds in production-index measurements and exceeded all but the mutton-type three-way crosses in lamb livability. They greatly exceeded the other classes in quantity and quality of wool, and in carcass-quality they approached the average of the mutton-type lambs.

The relative performance of specific three-way crosses is shown in Figure 1.

FUTURE RESEARCH

Work will be continued on three-way crossings, and additional Merino crossings will be made as the experimental flock of purebred Merinos increases in size. Crossing of Merinos with each of the mutton breeds will give some indication of the contribution Merino blood is making to the efficiency of the three-way crosses. The use of Merino rams on three-way-cross ewes will also give some indication of the feasibility of producing

RESULTS OF SPECIFIC THREE-WAY CROSSINGS

Purebred ram	Crossbred ewe	Three-way crosses 1951-55 average
 Shropshire	 Southdown-Hampshire	 LL-11.8% PI-78.5 Shropshire-Southdown-Hampshire
 Hampshire	 Southdown-Shropshire	 LL-23.4% PI-76.2 Hampshire-Southdown-Shropshire
 Southdown	 Hampshire-Shropshire	 LL-8.6% PI-72.5 Southdown-Hampshire-Shropshire
 Southdown	 Shropshire-Hampshire	 LL-21.8% PI-65.1 Southdown-Shropshire-Hampshire
 Merino	 Hampshire-Shropshire	 LL-17.7% PI-73.1 Merion-Hampshire-Shropshire
 Merino	 Shropshire-Hampshire	 LL-19.1% PI-74.6 Merion-Shropshire-Hompshire

LL: Lombs lost

PI: Production index

FIGURE 1.--The Shropshire X Southdown-Hampshire crosses with a production index of 78.5 was the highest of the three-way crosses, and exceeded the average for the two-way crosses by 12.2 points and the purebreds by 12.5 points. The Southdown X Hampshire-Shropshire crosses with an average number of lambs lost of 8.6 percent was the lowest for the three-way crosses, and was 15 percentage points below the average for both the two-way crosses and the purebreds. The production index may be considered a more significant measure of superiority since lamb production at about 140 days of age is included among other factors.

four-way crosses. Three-way-cross rams will also be bred to three-way-cross ewes and the efficiency of the offspring compared to that of the three-way crosses. All of this will require a number of years.

Whatever crosses are made, all will be based on top-quality purebreds. The importance of high-quality purebreds cannot be overemphasized. The success of any crossbreeding program depends upon the quality of the foundation stock. The ARS crossings made use of purebred flocks in which the inherent ability to produce meat and wool had become highly developed. Any similar program adopted by commercial sheep raisers would require the maintenance of purebred flocks of the highest quality and efficiency.

Indiscriminate crossing of sheep will not lead to predictable results. The ARS crossings are carefully calculated, scientific matings backed by data gathered during the past 40 years. They show the advantages of a definite and selective crossbreeding program which can be applied by commercial sheepmen. Although research is not complete, ARS researchers are convinced, on the basis of these findings, that production of hybrid lambs on a commercial scale is both feasible and practical.

Agriculture - Washington